In the Culinary Arts areas we have showers and dressing rooms off from that facility.

QUESTION #11: Is your automotive area arranged to your satisfaction?

MR. FARNSWORTH: We find that this is very satisfactory up to now. It gives an opportunity for these people to have a locker in there and maintain their uniforms and their coveralls if they want to, permitting them to make a quick change. Afterwards they can move promptly into the other parts of the facility for additional training in the academic area.

QUESTION #12: Are the classroom areas proving successful where there is no divider between them and the nearby shops?

MR. FARNSWORTH: This may produce somewhat of a problem eventually, although this year it has not. Primarily, our instructors go into the classroom and take a group of students for a general lecture. Later, they move directly into the shop area. Perhaps, as we move into the air frame section this may produce somewhat of a problem, but the air frame building will be separate and away from this section, thus permitting an expansion of the automotive area.

QUESTION #13: How many high school people are involved in programs this year?

MR. FARNSWORTH: We started out with about 390 people. Out

of this group there were about 90 adults who were returning for a high school certificate or adults who were paying tuition. This means we had about 285 to 300 students entering here as high school juniors and seniors.

QUESTION #14: How big a staff, including administration and secretarial, do you have?

MR. FARNSWORTH: I have an assistant principal and two counselors. We have only two secretaries who have been hard pressed to do the necessary correspondence associated with the hundreds of people who have toured the facility this year. There are, in addition, nine academic teachers plus 22 vocational instructors on the staff at the present time.

QUESTION #15: Just how do building or facility innovations come about?

MR. BLUROCK: I might say that the architects came into the picture fairly early. However, the educational specifications were under development by the staff here and with Odell-MacConnell as educational consultants for about a year prior to the start of construction. We tried to work as a team to pull together the philosophy that these people wanted. Opening up spaces so people are on display, so that materials are on display, and so that the function itself is on display.

MR. STURM: We wanted something different, because we have a philosophy here in Clark County that evidently differs

from many philosophies in vogue elsewhere. We feel that our youngsters, properly motivated, can act in an adult role as well as every one of us. Another thing is that we wanted flexibility, emphasizing small group instruction and individualized teaching. This is a school that's operated in an adult atmosphere and this is what we were aiming at from the start. The old four walls had to go, they have been obsolete for years, and our experience has served to strengthen that conviction.

MR. FARNSWORTH: I confess to some real doubts when this construction was going forward regarding the eating area. Mainly because it was to be entirely carpeted. I originally had requested that this facility be put into tile because I was concerned about its maintenance. I was overruled and I'm glad now that I was because carpet has been 100 percent effective, and the young people in the dining area have had great pride in it.

QUESTION #16: Have you had to send anyone back to their own school because they did not conform to your rules?

MR. FARNSWORTH: I have sent some back. The State law requires that a student remain in attendance until age 17. Those students who are over 17 and who do not adapt to our program are asked to leave. They are not generally admitted back into any high school. With perhaps a semester break they are given an opportunity to re-apply. At the semester break, I dropped 16 students who were failing in class and not doing

their work. We evaluated each case and if the instructor felt they would not be successful, we screened them out. We also dropped a few rough kids right at the beginning of the year. On the other hand, we have also accepted a few special education students to see how they would work out, particularly in the culinary arts area. Some of these people we had to drop. We made no bones about it to these students. We told them if they wanted to stay, they would have to do the job. We have this stipulation clearly accepted by the School Board and as a consequence we've established what we regard as a prestige school. It's been rather interesting in re-registering some of these youngsters now, with summer coming along, most other kids are talking about getting <u>out</u> of school -- but our youngsters talked about next Fall, "When do we get started, Mr. Farnsworth?", "When does school start again next Fall?" This is the predominant attitude that these people have now and we are thoroughly delighted with it.

QUESTION #17: What was your reaction from the parent when his youngster was dropped?

MR. FARNSWORTH: Before dropping any student, we had a conference with the parent. We told them what we were attempting to do, explained the situation to them. Some of them had a few tears in their eyes when their youngsters were moved out of here. Despite this, we let them know that that was exactly what we had decided to do and we followed through with

it. I don't think there's been any negative response.

QUESTION #18: In your academic subjects, one of the students said they had 45 minutes for each class. Is this required for the entire State of Nevada?

MR. FARNSWORTH: Yes, 45 minutes meets the minimum requirement as set by the State Department of Education. Now, some of these classes this year, we tried on a 45 minute basis for structuring. As it turned out, some of these students spend as much as five hours in Cosmetology, for example. They must also attend three more classes of an hour each. These two together amount to a 7½ or 8 hour day in school to which they also had to add another half hour or more traveling back and forth. We felt this was just too long a day, so we agreed to merely meet the minimum class requirements set by the State Department.

QUESTION #19: What have been your transportation problems?

MR. FARNSWORTH: Parking has given us many problems because we anticipated there would be public transportation to our facility for these youngsters. When it failed to materialize we found ourselves swamped with hundreds of cars for which we had not planned.

QUESTION #20: I'm still wondering about the carpeting. It certainly must have a life expectancy of a given number of years, whatever it might be. What about traffic trails that wear into the carpeting, are you going to have to replace an

entire room? Would a tile type carpeting application be better than your sheet application?

MR. BLUROCK: I think the life expectancy of the most heavily used parts of this carpeting are probably in the five to ten year range which is not too dissimilar from that for resilient tile. I would only respond this way: by the time we get through with the third phase we will have moved enough walls around so that we probably won't have the trafficways in the same places any more. On a maintenance basis, I think you'll find that your carpeting will pay for itself over a short period of time even though it has to be replaced in some areas. They actually clean this carpet with lacquer cleaner when they get a gum or some such substance stamped into it. So, if it'll stand up under that type of maintenance, it's pretty good material. I think you should assume carpet to require regular maintenance, much as you would painting or varnishing.

QUESTION #21: How about the stairway where you have a turning problem, will carpet show excessive wear at such points?

MR. BLUROCK: Well, there's no question about it -- the stairways will be replaced on some type of cycle. However, we could not comply with the educational philosophy that was built into this building without also carpeting the stairs. I'm sure you are aware that stairway tile is also replaced more often than the same type of tile laid in corridors.

QUESTION #22: What about matching up this carpeting when you

have to do repairs or effect replacements?

MR. BLUROCK: Did you ever try to match tile? It doesn't work too well, does it? However, we do have a supply of carpeting on hand that will probably work just about as well as matching tile, which, frankly, always leaves something to be desired.

QUESTION #23: I'd like to pursue that maintenance question a little further in terms of the size of the maintenance force for this building, as well as the daily maintenance program.

MR. FARNSWORTH: At the present time we have two custodians on during the course of the day and four evening custodians. Also in the evening I have two people who are responsible for this building and one person in each of the other areas. Mostly, this is a matter of vacuuming, going through the area about twice a week. We find that this quite adequately takes care of it. The toilet facilities are still our major concern, it still takes more custodial time with toilet areas than any other place in the building. We do have a district team that comes around and does most of the outside maintenance. We have a manpower class in landscaping out here, too, and these people are helping us on the landscaping and generally keeping the facility up on the outside. I would say that the general overall maintenance is much less than in some of the other local schools. I had a junior high school in the city

before coming into this facility, with floor space about 2/3 the area of this one, and yet I had more people busy with maintenance than is true here, which gives you a fair indication of the difference.

QUESTION #24: A question on educational organization. Is the two-year high school with only junior and senior classes a temporary transition, or will there eventually be sophomore and freshmen classes as well?

MR. STURM: First of all, we will maintain this facility on an 11th and 12th grade basis. There is a possibility that we will move into a post-secondary program. The conception of this school here five years ago was that it would include 11th, 12th, 13th and 14th grades, but because of certain limitations, we have kept it an 11th and 12th grade institution. We are moving into the 13th and 14th grades this coming year. We are not at the present time planning on moving down two grades. However, I personally don't think we're beginning early enough with vocational-technical education. I think the preparation has got to start in the early school years. I am convinced that it's got to go back to simple occupational information first presented in the kindergarten year. With that type of early indoctrination, young people will arrive in high school already aware that the world of work has ample dignity to capture and hold their interests.

QUESTION #25: In your post-secondary offerings, what percent

of time do students spend in the lab and what percent of time in related courses?

MR. FARNSWORTH: Again, this becomes a varying situation, depending on the class being offered. I would say that in many cases it would probably run about 20 percent in academic work. In some cases the academic/vocational distribution might be about even. For example, as we get into our highway technology program, it would be necessary to bring in quite a bit of drafting, some aspects of mathematics instruction, and so on, which would possibly give those students a daily program top-heavy with academic work. Our basic concern, of course, is not with this distribution per se, but with tailoring vocational programs in the best way to produce the best workers.

QUESTION #26: Discuss the three most important guidelines with which an architect can be furnished by the school district that will enable him to tailor a fully functional vocational-technical facility.

MR. BLUROCK: The physical environment that is expected out of the facility should be portrayed to the architect, as well as how the facility is going to be used. Also, the development of a budget should be worked out with the architect and should have flexibility to allow it to be expanded or contracted. But, most important, it should be agreed that the entire program will be a team effort.

QUESTION #27: When planning a vocational-technical school, how would you distinguish the architect who is purposefully creative from the one who is aimlessly innovative?

MR. RUTGERS: I think the way an architect responds to educational specifications is tremendously important and indicative of his ability to work within the framework of that school district. If he does not communicate well with the Board, you've got a problem immediately. Of course, the educational specifications have to be written in a complete and understandable way. Assuming that the architect responds appropriately to the educational specifications, I think one should study how he handles specific requirements. Does he come up with solutions to these problems, or does he fail to solve them even though appearing to be innovative. In other words, is he innovating and still offering a poor solution? Perhaps he displays a different approach, but the basic problem remains unsolved. To me, innovation means change, and change can take two directions, it can either improve a condition, or it can end up creating a condition that is worse than that posed by the original problem.

QUESTION #28: At present, what is the major advantage of utilizing the systems approach to construction?

MR. BOICE: One of the problems we have here is the distinction between the system, as exemplified by the SCSD system, and the systems approach to the design and construction of facilities. First of all, the systems approach does

a number of things. It forces you to start at the very beginning and delineate exactly what you want to do with the facility. As you put down the things in educational specifications that you want to do in this building, you necessarily have to bring your educational program along as you proceed step-by-step to the finished building.

The systems approach was designed to improve quality through the building process, to improve performance through that process, by setting down agreed upon performance levels and then making sure that these performance levels are maintained by means of a system of testing and evaluation. The next thing I think is important about the systems approach, and a very critical part of it, is the team approach from the standpoint of integrating all of the building systems into a composite, well functioning whole. This has to do, of course, with the integration of services and the integration of major elements of the building that we work so hard to develop. In utilizing a systems approach you are bringing together those people who have responsibilities in a large number of areas in a team undertaking. This will involve not only the mechanical, electrical, structural, and other engineering professions, in cooperation with the architect, but also the trade unions and the craftsmen that will have to put these things into a finished product.

QUESTION #29: Of those features of your building and instructional complex which represent a <u>unique</u> <u>departure</u> from

traditional practices (i.e., floor covering, student selection, adult learners, or whatever), which would you single out as the one having the greatest educational impact?

MR. FARNSWORTH: I think it's a combination of many things that resulted in an atmosphere of flexibility, or an awareness on the part of teachers that they could try new things, that they could use new approaches, and that they were not bound by the conventional ways of doing things. Much of this was created by the openness of the facility. The use of floor coverings was important, but I would hesitate to say that it was more important than the other features. I read recently that many times in creating vocational-technical centers, it's important to set them completely apart from the traditional approach to education in order to bring in a new atmosphere and change the tired old image for this type of program. I think this is exactly what we have attempted to do in our vocational center, and we are exceedingly pleased with the result.

QUESTION #30: Describe a way that school districts can insure the use of quality materials in the construction of their vocational-technical facilities which remain within the limits set by their budgets.

MR. GUINN: The key word in answering this question is "pre-planning". By pre-planning I primarily mean settling upon what we are going to do, because the budget that you set later on becomes more or less a fixed thing with little flexibility

in it. Develop the full scope of what you're trying to do and then in some way go through an aggressive program of architectural and educational explanation so that you can develop what you want your architect to do. Then select your architect, remembering that the minute you hire that individual your budget is going to be governed largely by what he does. As an educator you will have to lean on him tremendously to give you quality results in a building.

QUESTION #31: For just a moment, give full rein to your imagination and forecast for us how you envision the vocational-technical facility of ten years from now will differ from even the most modern one of today.

DR. MAC CONNELL: First, the building no longer will be just to keep the rain and sun out. It's going to be a teaching and a learning tool. As we think of it, we see not only the facility itself, but the site as well. Down in Rio we're doing a project with Mr. Blurock as the architect. We are keeping that site in its natural state with a whole stream running through the school. (We may lose a couple of kids, but we hope they'll be from large families and we won't get criticized too much.) Natural beauty should not be needlessly disturbed. Along with this willingness to incorporate naturally appearing beauty into our physical facilities must come an equal willingness to make adequate provision for inclusion in the school plant of all the scientifically useful innovations and developments that emerge from the research centers of the world.

TEACHING AND EDUCATIONAL MODELS

Mr. Al Russell, Director
Education Division, Lennox Industries
Marshalltown, Iowa

The question has been asked by many educators: What is a company such as Lennox, best known as a manufacturer of heating, ventilation, and air conditioning equipment, doing in the teaching model or educational model business? The simple answer to this is that we have our own vocational-technical education program that we run continually. We employ high school graduates and undertake to teach them how to install and service our equipment. We must also have people who can sell these products. Such personnel very frequently are graduate engineers. In all instances, we are called upon to teach them the proper utilization of our equipment. So it is in this sense that we have an educational program contained within Lennox Industries.

School facilities are also of very great interest to us because the design of the building, the method by which the architect puts the pieces together, both provide the potentialities for the proper use of our equipment. Going hand in hand with our concern for the special nature of educational plants is our increasing need to understand the education process, particularly as it touches the area of vocational-technical training.

Two years ago at a vocational-technical meeting in Palo Alto, Lennox Industries became acquainted with Professor Neil Mitchell of the Harvard Graduate School of Design. Since then

we have worked quite closely with him on a number of different projects. One of these dealt with putting together a teaching program designed around a series of educational models. It was Professor Mitchell's feeling that in many areas of his teaching it was much easier to present a model to demonstrate a principle. This succeeded in getting the student involved in feeling, touching, bending, or somehow using the model. Once involved with it, his interest was aroused and he could then begin to move into the mathematics and the technicalities of just what he was doing. This, of course, is not a new or novel way of teaching. Everyone who has been in the educational field for any period of time has attempted to do this in one way or another. I am discovering in my travels to the various universities that many professors have developed items of this nature themselves in order to meet their own teaching requirements.

The thing that became very evident to us, however, was that while many teachers or professors did this, there was no central clearing house for these ideas which could lead to the eventual manufacture and general distribution of instructional models. It appeared to Lennox Industries that this was a void which needed to be filled. In looking at this total problem, we felt that here was an area in which our own special skills and experience could be brought to bear. We did not envision either a large or a lucrative market, but rather a place where we could make a modest contribution in our own way toward furthering the educational process.

It soon became apparent that we would have to begin by learning a whole new language and even now we certainly lay no claim to having mastered it. We forced ourselves to look at quite a number of different ways of doing things. Different from old familiar ways, yet ways which were basically more instructive. We found that some of the proposed models were quite simple and could easily be made out of plastic, wood, or rubber. While not "kidproof", most of them could be classified as non-breakable with ordinary classroom use. Model durability is absolutely necessary because the basic idea is to encourage kids to work with them.

Early in our progress we discovered that this could be quite a sophisticated field. Tolerance, for example, often had to be held to 2/10,000ths in order to demonstrate an important concept accurately. At present, we have worked out a basic group of demonstration models. As might be expected of an engineering firm, we began with structural models. This group covers beams, columns, frames, principles of stress and strain at a given point, and various models depicting the distribution of weights, stresses and strains. The second basic group of models illustrates a more qualitative analysis of these principles with concern centering on more accurate measurements. Other models are designed to give insight into the strength of special materials and some related ideas essential to the full understanding of basic structural problems.

Our search for dynamic demonstrations has, of course, taken us to many schools other than Harvard and we have found

that a large number of educators have developed extremely useful models in the area of mechanics. These are models which likewise deal with basic principles. In air conditioning or heating, for instance, there are models to demonstrate convection and chimney effects, as well as principles of radiation. These are all fundamental principles that sometimes are exceedingly difficult for the student to grasp in any other way. A good many of these models in the mechanical field are still either on our drawing boards or remain in the thinking stage. However, by the end of this year there will be quite an assortment of things available to the general educational field.

We have developed a few parameters in looking at these models as they have been made available to us by educators. Frequently production costs turn out to be prohibitive in the light of their probable use. Typically, we take the ideas one at a time, cautiously feeling our way along. We look toward having a wide range of models which will prove economically to be in the ball park. We also hope that they will have great durability permitting their use over and over again for a number of different classes. As a general rule of thumb, we would hope that at no time would any of the models be valued at over $100. Most of them would be considerably less costly than that.

We've found in Canada that many of these models are of interest to them in their mechanical drawing classes where they are looking at perspectives. Most can be placed in full view

in front of the class while the instructor walks around the room continuing his lecture. The visual effect remains before the students throughout the discussion. This, perhaps, is one step beyond other types of visual or audio aids. Visual communication, as you all know, is typically superior to audio alone. When the two are tied together and coupled with student involvement, then one has an ideal teaching and learning situation.

In closing these remarks, let me say that Lennox Industries is excited about its new undertaking in the world of education. But it should be emphasized that we must still depend to a large extent upon men in the classroom to furnish us with suggestions for teaching models. Ones that will not only command and hold students' attention, but at the same time bring home to them concepts that might otherwise elude them. Even if our success is merely that of significantly shortening the total learning process, we will feel fulfilled. With your expertise in the fields of instruction and learning and ours in engineering talent, we form a team that can make a truly noteworthy contribution to the cause of education.

THERMAL ENVIRONMENTS

Mr. Norman Rutgers
Director of Environmental Systems
Lennox Industries
Marshalltown, Iowa

I'd like to discuss just what we mean by good thermal environment, cut it apart and look at it from various angles. I think we have all attempted to force coordination of various facility components, various elements, into a school and as a result we've ended up with a final product that while it may have been reasonably good, we know it could have been a great deal better. Basically a good thermal environment for vocational-technical schools is very similar to the type of thermal environment we would like to have in any academic situation. There are, however, some specific areas where additional attention to thermal environment must be made.

Each new school presents its own special problems. The educational vacuum for high school students who could not, or did not choose, to go to college was very apparent. There is no reason in the world to believe that every high school graduate <u>should</u> go on to college; but we should give him the opportunity to continue his education in specific areas so he can make a greater contribution to the community and to himself. Also, we should look more toward the adult who wishes to increase his skills and upgrade himself. The vocational efforts in almost every community are directed not only to the 11th, 12th, 13th, and 14th grades, but also to interested adults of the community who wish to increase

their own skills and abilities. There is a vocational technical facility in St. Paul, Minnesota, for example, which actually has 6000 students ranging from the ages of 19 to 60 years, demonstrating that this does meet a very definite need.

The United States will show an increase in students in the next few years from about 5 and 3/4 million to over 14 million. But we will deal effectively with this tidal wave of students only by providing the type of facilities that are required for their varying needs. To give you an idea of one recent trend in this country, in 1944, 66 million dollars was spent on vocational education. In the next twenty-year period, three hundred and thirty-three million dollars was spent for vocational-technical education. In 1965 it jumped to 620 million; In 1966 it was 730 million; and in 1967 the figure rose to 815 million dollars! If we take the 1966 figures and wonder where this money came from, out of the total of 730 million dollars, 215 million came from federal funds. The remaining 515 million came from state and local funds, which shows rather clearly that this is not a totally federally sponsored program. The federal money is normally met by matching funds or even by more than matching funds at which point it becomes very much a local problem with relatively modest federal support.

Special needs require early planning and I think others have touched on the necessity of getting into a planning program at a very early date. The Las Vegas School District

had been planning for a number of years before they started their first vocational-technical facility. Preliminary planning should involve not only educators, but representatives of local industry, the selected architect, trade unions, and local business and professional clubs. It's amazing how much you can grease the ways in eliminating later conflicts with unions, for example, if you include them in early plans. If people understand what the purpose of the program is on a prior basis, the thing moves along pretty smoothly. Too many schools have been planned and built in a hurry. Planning in a hurry will provide a very expensive type of facility and it will never quite fulfill its educational needs.

The architect's role in designing the modern school is extremely important. My number one suggestion to any school board or any administrator would be to select the most progressive, the most up-to-date architect that can be found. Find the architect that is aware of the latest improvements and advancements in construction; an architect who is not afraid of a little innovation, provided, of course, that innovation has a purpose. If we continue to plan and build new schools based only on our past experience, we're merely going to repeat our former mistakes. If we're going to make mistakes, let's make original ones.

Without question the educational specifications become tremendously important. Without them, I don't think a good planning job can even be started. It won't cost the district,

in the long run, one bit more to hire a top-notch architect than it will to hire a poor architect. (I'm making the assumption there are "poor architects.") In fact, the poor architect can frequently cost the district considerably more than the full fees of a truly superior one.

The term "learning environment" includes many important interrelated factors. One of the most critical, but the least understood, is that of thermal environment. Good thermal environment will provide an atmosphere in which the student is unaware of any physical discomforts. He is neither too warm, nor too cold. He doesn't have too much air moving over him, nor is he sitting in a stagnant pool of his own body conditions. It includes a lot more than just heating alone. Up until a few years ago, the only relationship to thermal environment was the question, "Do we have a heating system?" When we finish examining this question we will find that the heating system, while it is important, is certainly not the major factor contributing to a good thermal environment. There are other elements in every school situation that make heating a rather minimal consideration.

Let's take a look at all of the ingredients which make up a good thermal environment. We'll cover these one by one. Constant air circulation in any occupied area is very important. If you stop the air circulation, the air becomes stale; it grows stagnant and stuffy, and odors will collect. Just walk into a school that's approximately 15 to 20 years old that does not have good air circulation. Remember, it's that familiar old school with the gymnasium in

the center, the principal's office on the right-hand side as you come in, and the classrooms fanning out around the gym. Open the front door and take a good deep breath. You can smell the sweat socks that have been in the lockers for the last ten years. That odor just seems to permeate the entire school; it hangs there and stays there. To repeat, air must be circulated. You have to pick up the odors, move them out, and bring in fresh air. If you do not have constant air circulation, the air will stratify. In other words, warm air will move up, collect and hang, the cold air will then drop down. Between the ceiling and the floor there can be as much as a 12 degree temperature difference. A student may be standing in a pool of cool air while his head is bathed in a considerably different temperature area, the combination of which can be most disconcerting, and certainly it does not contribute to a good learning environment.

If there is a lot of glass area, and many of these schools have been built this way, we very likely do not have good air circulation. We find that air will collect along the cold glass surface on a cold day of 25 or 30 degrees and will soon start cascading down the glass surface. As that air moves down the glass surface, it will pick up velocity; sometimes as high as 80 to 100 feet per minute. It will move across the floor, chilling feet as it does. In order to stop this cold movement we find that a vertical column of air should be introduced at the glass area. This will eliminate, or, to a large degree, minimize the problem.

In good air circulation, air is constantly mixed, but ideally on a gentle basis. There are some agreed upon requirements of air velocities in any space. About 50 feet per minute comes close to the acceptable maximum. If you get much below 15 feet per minute, air starts to stagnate. About 25 to 30 feet per minute would represent a reasonably good environment from an air circulation standpoint.

Air in academic spaces should be changed four to five times per hour. But now let's look at a vocational-technical facility. We have some areas in a vocational-technical facility which will require considerably higher frequency of air changes. When you get into your laboratories, you may want to exhaust virtually all of the air you're introducing into the space. If it's hot outside, you're bringing in higher temperature air. You have to cool it down to maintain a comfort level, demanding a greater capacity. The major point here is that you must consider the difference. In a welding shop, or an auto body shop there is an exhaust problem. You have to replace that air, so you have to have an air makeup provision introduced into the mechanical system.

Fresh, outside air needs to be filtered and treated before it is brought into the teaching space. We can clean air, of course; a problem that is linked very closely with the problem of air pollution that is becoming the number one topic in many communities. For a while we thought that California, and particularly Los Angeles, had a corner on air

pollution. We find now by direct comparison that Los Angeles is not nearly as bad as parts of New York on certain days and unless we develop methods of filtering and cleaning air, we may merely be bringing in an outside problem and creating a new problem inside the classroom space which is equally as bad as it was before it got into the school.

Electronic air cleaning is moving ahead. We're seeing more and more of it being used. It's not cheap, but it is coming down in cost. Using charcoal filters proves an effective way of eliminating odors. These are mechanical methods featuring special devices which can be incorporated into the mechanical system. In older systems, a number of years back, we used to simply open windows for ventilation. This is no longer a sensible solution. Air conditioning virtually allows you to compact a building and by compacting you can save construction costs so you get a trade-off that makes real sense. When you did open windows in those old schools, of course, it was a direct invitation for all the airborne dust and dirt to come right in with the fresh, outside air. In newer school design, we find far fewer windows. If you noticed the Clark County vocational-technical school, there was very little glass. Glass was merely a vision strip which may lead some of you to think of me as being "anti-glass." I'm not at all anti-glass, but I hope to point out to you, if you use great expanses of glass, what you will have to do to counteract the negative thermal effect that that glass will cause. There are areas in between total glass and no glass at all that strike a more practical balance.

One thing about fresh air is that you must control it. This brings us to the subject of air temperature. The human body does not function too well at extreme air temperatures. Circulation is not the only requirement with which we must be concerned. Air really should not vary much more than a plus or minus 1 1/2 degrees from the control center. In some areas you will find a two degree plus or minus variation. In such cases, the body will begin to react to this much change and when it senses a change, it immediately sets up a process to offset it. The physiological relationships of man to his environment provide an extremely interesting study. This is one of the areas in which we are attempting to work with the Graduate School of Design at Harvard University. Body temperature adjustments take energy; it distracts a person from his studies and lowers his efficiency. The human body is also sensitive to the rate of temperature change. In other words, if you change the temperature in a room gradually, the body will adapt to it without too much straining, but if you bounce temperatures back and forth too drastically the body will react strongly to it.

Recent research also suggests that if 72 degrees is an optimum temperature at 11 o'clock, it is not necessarily true that 72 degrees is the optimum temperature for the same group of students at 2 o'clock. We think we might be on the verge of programming temperatures to arrive at ideal temperatures for the time of day following, say, a lunch period, and particularly programming temperatures in relationship to the

academic courses or the studies that are going on. Very little is known about this at the moment, but since we are living in a computerized age, there is no reason in the world why we can't program for temperature changes as long as we know at what levels we should gauge it.

We should refer some to sound. We have, in the mechanical area, tried to reduce sound levels. On one occasion, we were able to get the mechanical sound level down to the point where the ballast in the fluorescent tubes was perceived as noisy and began to bother the people within the building. This was too much success. So now you reverse that trend and you come back up to a sound level which is compatible to the surroundings. A dead, quiet sound is actually most irritating. You need to have a level of sound but you have to plot the frequency of it against the pressure level of the sound.

Interestingly enough, heat is never <u>added</u> to the body. We never, even when we're in a heating situation, apply heat to the body. What we do, however, is regulate the heat <u>loss</u> from the body. Now, this is understandable when you think in terms of your body temperature being 98.6 degrees. Therefore, if I'm adding heat to the body, I've got to add heat at a higher temperature. My room, then, would have to be warmed to a level above 98 degrees before I could transfer heat from the room to the body. So when I maintain a 75 degree temperature, I am merely controlling the rate at which the body heat is being lost and when I allow the room temperature to drop down to 60 degrees, I begin to lose heat from the

body at a faster rate, making me uncomfortable. I start to shiver simply because my body's physical processes are attempting to offset this increased heat loss. We heat the walls and the furniture, and all of the appointments. You're bringing them up to a temperature level and you're controlling the rate of heat loss from the body at the same time. Mechanical systems control the rate of heat loss merely by varying the ambient temperature surrounding the body. The closer the air temperature is to 98.6 degrees, the more difficult it becomes for the body to lose heat. This is apparent in the summertime. You feel stuffy. Your room starts to build up without air conditioning and your body cannot lose its heat, therefore your internal temperatures start to rise, just fractions of a degree, perhaps, but even so an extremely uncomfortable situation occurs.

Earlier we touched on air cleanliness and pollution. This is becoming more and more a major factor in mechanical design. Dirt and lint from clothes are all about us and the city air contains many contaminants. These contaminants are constantly being brought into the school itself. All such foreign matter should be removed from the air that the student breathes.

Today there is an additional area provided for in the plans of new schools designed to offer atomic fallout protection. This is a core area in which the students will congregate during a critical period. Of course, when you start to bring more students into a smaller area, you imme-

diately change your thermal requirements. This requires shifting one's capacity from a total area into a confined area so that we increase the air volume to maintain the necessary minimum per student. Under a critical condition we extract the airborne radioactive particles from the air being brought in, as well as cool the air so that the temperature rise is controlled within the space. This can be accomplished without great additional cost, and has the added advantage in that it combines a school protection area with an essential community function. Certainly a lot more research must be done in this area and more people in the mechanical field should gain an interest in this research. Our basic tenet, however, still remains: air cannot be cleaned unless it is moved and circulated.

Let's look now at one of the biggest culprits in maintaining a level of comfort and that is the problem of heat gains. Our vocational technical facilities are being designed and used for year-round operation. Therefore, it is almost mandatory that we take a second look at the mechanical systems that go into a vocational technical facility. Let's pass over for now the summer months. We can all agree that in the summertime, in almost every American community, there will be temperature rises which require some form of mechanical treatment of the air to insure physical comfort. But in the winter, there are some very interesting heat gains that occur in a building where the outside temperature drops to zero.

Suppose there is a lot of glass area in a building.

Depending on the exposure, glass can add in excess of 240 b.t.u.'s of heat per square foot of glass. Relate this to the fact that in one ton of cooling there are 12,000 b.t.u.'s. Some simple arithmetic shows that a relatively small amount of glass area under some conditions of exposure can soon require a full ton of air conditioning to offset. Heat can build up in a hurry.

We have another problem that's related to this. Our lighting levels are going up sharply. Ten years ago our schools were designed to flood areas with about 70 foot candles. Today, 70 foot candles is at the lower level. We now recommend up to 100 foot candles and, if we would listen to the people in the lighting research, the watts per square foot would increase still more. Let me elaborate on this last reference. Today, for each square foot of building we typically have approximately 4 watts of electrical power. This is directly related to the heat input into a space since every watt of electrical power consumed will place 3.4 b.t.u.'s of heat into the area. We started out with 4 watts per square foot and we're now talking about lighting intensities going up to 100 foot candles from the old base of 70. In some instances, as much as 250 to 400 foot candles in lighting intensity is being recommended. While I am not a lighting expert, I can tell you that if we go from 4 watts to 6 watts per square foot, you're going to add a whale of a lot of heat to an area which will have to be countered with additional cooling capacity.

Take a conventional 900 square foot space at 4 watts

per square foot, we have 3600 watts total. This would convert to about 12,000 b.t.u.'s, so we'll need a ton of cooling put in this room just to offset the heat from the lights. I'm merely pointing out what some of our problems might be. The maximum solar gain, plus the lights, plus the students themselves in a 900 square foot classroom can produce up to 60,000 b.t.u.'s. Now in those parts of the country where we occasionally have temperatures down to 25 degrees below zero, we would not need <u>any</u> heat in the classroom even on a zero degree day. We have enough heat from the lights, from the sun (if the sun is shining) and from the students to maintain an adequate balance. If you move up the outside temperature level to 10, 15, or 20 degrees above zero you are into a cooling, rather than a heating situation.

It's also an important problem to bring a building up to temperature in the morning so that it is comfortable when you go in. It's also a problem to maintain the building at night. But once you occupy the building and school is in session, the night heating situation may well disappear and be replaced almost instantly by a cooling one.

We'll consider a little about zoning before we get into the twilight period where we need some heating around the perimeter but at the same time some cooling on the inside. These are problems of control. The ingredients for a good thermal environmental system, then, are a supply of fresh air, with the air contaminants removed. If the air is at an abnormally low or high temperature, it has to be treated -- either heated or cooled. We have to have proper humidifica-

tion, and finally we should constantly circulate this air.

Let's look for a time at why schools should be air conditioned. Rather than insist that schools be air conditioned, perhaps we should ask the question, "Why should schools be air conditioned?" This is what the voter is going to ask. And he is not going to take a statement and believe it. He's going to question closely this expense. First, most vocational technical schools are being planned for 12 months. If you're going to use that school during the summer period, air conditioning is certainly important. If the requirements that we have set forth have any validity at all, then I think that we should recall that even in the heating periods, air conditioning or cooling in some manner may be important.

We do have a communication problem and that centers on the reaction of the public to the term "air conditioning" and I wish we could find another term. There is a built-in resistance on the part of a good many people, who perhaps do not have air conditioning in their homes, because they feel that it is a terribly extravagant frill. At any rate, we have a public relations problem. As educators, as architects, as industrial people, we must school the public on the necessity of establishing a good thermal environment.

Let's look briefly at the various methods of air conditioning that can be accomplished in the school building and also examine their cost.

The system similar to the SCSD solution came out at

about $750 a ton. The mechanical costs for SCSD have been maintained at virtually the same level as they were 4 years ago when they were figured. The gas-fired, multi-zone, on-the-roof type has some obvious advantages. You put the system on the roof and generally speaking you do not lose any building space. You still need some space, of course, for incinerators, water heating, and so on. Reference here is only to the heating and cooling equipment. We could take the same equipment and put it inside a building which will require about 300 square feet for every 60 tons of cooling capacity. If we use a hot water system, and use a direct expansion coil, the price goes up some, as do also the spatial requirements. Space requirements do increase if you go to a hot water and chilled water system with a four-pipe distribution system.

What is clear to the environmental specialist is that the school must be capable of changing thermally just as much as the physical spaces must lend themselves to change. A school without flexibility is obsolete the first day that students walk in the door. The traditional school has been a series of inflexible boxes which, among other things, contribute to some thermal difficulties.

Now let's consider the design of air conditioning for schools. Teaching methods evidently become obsolete faster than General Motors cars. We now need, for instance, the ability with audio-visual to darken the room and to lighten it. In the past when the budgets were drawn and air condition-

ing was merely added to the conventional design of the school, the School Board went carefully over the bid. The first thing that was cut out of the job was air conditioning. Nobody really thought about it as being a design problem. Frequently, air conditioning can become a design tool and this is the way we are beginning to use it. As such, the basic space requirements can be met at less cost. Let's see just what kind of savings we can get from proper design. Basically, if you can cut down on the perimeter construction of a school you're going to save money. In Atlanta, Georgia, the vocational technical school reduced its exterior walls by 2,593 lineal feet. By reducing that amount of lineal dimension, they saved more than a quarter of a million dollars on construction, or more than enough to cover air conditioning.

Some types of insulation can also reduce cooling requirements by one ton for every six classrooms or about $750. But more important than that, for every ton reduced, you reduce the operating cost. That continues for the entire life of the building. Again, insulation has a place. You can, of course, over-insulate. You have to trade off now the added cost of insulation against the reduction in cooling. If we can reduce the number of window frames and their installation, we can save for a normal-sized window about $50 to $60. Along with this, glass breakage can be a major problem in many of your more metropolitan areas and, glass must be covered with shades or drapes if you're going to employ audio-visual teaching. Again, I'm not against glass -- if you

want to use it, fine, but bear in mind that glass effects your thermo-environmental system, and other factors, too.

Entrances that are faced away from the prevailing winds reduce the heat loss. But windows that are protected by shade trees will reduce solar gain. Also, if you can face windows to the north or to the east you will reduce the amount of solar gain that comes in through them. If the building has a narrow dimension and you can use that dimension on an east to west axis, you are better off than putting the long dimension facing the west where you get a greater sun gain.

We think a good thermal environment can reduce the number of doors. The door is a kind of traditional thing. We've always had them, but we need not always retain them. A door is not necessarily a means of entering. Frequently a door is a means of keeping people out. I think in any part of our educational facility we want to invite as many people into the facility as we possibly can.

In a good thermal environment we can also achieve savings if we go overhead, some pipe tunneling, and trenching. We can reduce equipment rooms, too, if this seems to be desirable for the school. In an equipment room that's reduced to $15 per square foot, for instance, you can save $7,500 to $12,000 on non-teaching space. These are things to at least consider. A good thermal environment should have outside air introduced into the building under controlled conditions. Now, the real value here, in addition to freshening the air, is that for temperatures down to 20

to 30 degrees, I can use that air that's outside at that temperature and cool with it rather than start my compressors and use electrical power.

What are the benefits of a good thermal environment? Well, with a good thermal environment, students learn more. This, I think, has been fairly well substantiated in reports available. Figures have shown that 23% of the elementary students improved their grades in a proper thermal environment compared to kids in an identical space adjacent to them. We are now undertaking a full year study on this kind of comparison. What about the thermal effect on teachers? I think here is one of the real indirect benefits because the recruitment of teachers can be a very difficult problem today. It has become very competitive and I'll bet that if you have an air conditioned school you will have more applicants for your good jobs than if you are trying to bring them into a non-air conditioned facility. Good thermal environment not only attracts good teachers, but allows the teacher to perform at a higher level of efficiency. It reduces his or her fatigue. It does all of the things for the teacher that we have been talking about for the student, and yet, it's just as important for teachers as it is for students.

A good thermal environmental system will allow windows to be closed and the air filtered, which will reduce cleaning within the building itself. This is quite significant. The glass reduction that air conditioning will allow will also reduce vandalism and glass breakage. We have found

that for every dollar that you can save on maintenance and operational costs per year, you can afford to put about $8.00 more into your initial structure.

Many specifications are requiring maintenance and service contracts to be offered by the equipment manufacturers. SCSD required this. It is changing the structure of our company because we are going into the service and maintenance business on a national scale. Here is what it does. When you as the educator or as the architect specify that the manufacturer who is going to supply the equipment shall be responsible for that equipment for a minimum period of five years, with an option for an additional 15 years, the manufacturer who is putting the component parts into that product is going to look pretty carefully at each piece and each part because it's his baby should it prove faulty. He must pay for the replacement components and this insures a higher level of maintenance at a lower overall cost. Our maintenance costs are now running between 3 and 4 percent per year. It can go down from that point. That 3 and 4 percent figure is computed on the installed cost of the mechanical system. A service contract can be tailored to fit the local maintenance program. In other words, if a school district has extensive maintenance personnel, we can write a service contract merely to come in four times a year and do a total inspection and an on-site adjustment. The rest of the year the local district maintains the product. If you have a small school with no maintenance per-

sonnel, then you can buy a total maintenance program. I think you are going to find more and more emphasis on maintenance in the immediate future. Air conditioning is not a frill today, nor is it a luxury; rather, it has become just as important as the bricks, the blocks, the roof, and even the teachers. An air conditioned school will not give you a good educational program, but a good educational program will function better in a good thermal environment which, of course, would include air conditioning. With air conditioning, you'll also find other groups utilizing the facility more for evening meetings, and for important gatherings. The school library can do double duty in a small community by serving as a community library, as well. Round-the-clock utilization reflects back again to a sound thermal environment. With a flexible, adaptable thermal environment in your school you have laid the groundwork for an educational facility prepared to serve you and your community at an optimum level of efficiency.

APPENDICES

APPENDIX A

CONFERENCE CONSULTANTS AND PLANNERS

Dr. J. Clark Davis
Professor of School Administration
University of Nevada

During his career in the field of education, Dr. Davis has served as a classroom teacher, principal, superintendent, and college professor. At the present time, he is directing the Research Coordinating Unit for the State of Nevada in addition to his regular faculty duties at the University of Nevada.

Dr. Davis has acted in a consultative capacity for many of the school districts in Nevada, and has assisted in conducting numerous surveys, studies, and planning conferences, all relating to programs and facilities. In addition, he has served as an educational consultant to various other states and to private foundations.

Dr. Davis has authored various articles for professional journals and has published many monographs relating to the area of school administration.

Dr. Stephen Knezevich
Associate Secretary
American Association of School Administrators

Dr. Knezevich has had many years of experience in the field of education, having served as a teacher, principal, superintendent, and college professor. He has been a Professor of Education at Tulsa University, Iowa University, Florida State University, and a Visiting Professor at several other universities, including the University of Colorado. He has written four textbooks in the field of school administration, and has authored numerous articles for professional journals.

At the present time, Dr. Knezevich is Associate Secretary of the American Association of School Administrators. He also acted as Chairman of the writing committee which was responsible for developing the GUIDE FOR PLANNING SCHOOL PLANTS for the National Council of Schoolhouse Construction.

Burnell Larson
Superintendent of Public Instruction
State Department of Education
Carson City, Nevada

Prior to his appointment to the position of Superintendent of Public Instruction for the State of Nevada, Mr. Burnell Larson had served as a teacher and administrator in the school systems of Nevada. He was, for several years, the Superintendent of one of the largest geographical school districts in the nation, and in this position was responsible for the planning of many school facilities.

Mr. Larson is a member of the Council of Chief State School Officers and is a member of the Board of Directors of the Nevada Education Association. He has served as consultant to educational conferences, and has been instrumental in the development of educational programs.

John R. Boice
Associate Director, School Planning Laboratory
Stanford University

Mr. Boice has been a member of the School Planning Laboratory staff since 1949. He has taken part in or directed over thirty-five studies and surveys throughout the western United States, Alaska and Hawaii. These studies were concerned with all phases of the educational population studies, master planning, educational specifications, building plan evaluation, finance, administrative organization and related areas. He was responsible for the administrative intern program in the School of Education, which involved directing field evaluation studies and conducting weekly seminars for administrative interns.

As Associate Director of the Western Regional Center, EFL, he is responsible for the directing of twenty-two school planning projects, elementary through university levels. In planning he has worked extensively with school boards, superintendents, architects, engineers, school planners and the general public.

Raymond L. Sturm
Director, Vocational and Adult Education
Clark County School District
Las Vegas, Nevada

Mr. Sturm has enjoyed a variety of experiences in the general area of vocational education. He has served as head of the

Trades and Industries Division of the Central Utah Technical Institue, and as Officer in Charge of Vocational Technical Training for the United States Naval Station in Memphis, Tennessee. In addition to his experience in the field of vocational education, Mr. Sturm has also acquired valuable experience in industry, including experience with Douglas Aviation Company. Vultee Aircraft Corporation, and Ben Hur Products Company.

Mr. Sturm is at the present time Director of Vocational and Adult Education for the Clark County School District.

Clayton E. Farnsworth
Principal, Southern Nevada Vocational-
Technical Center
Clark County School District
Las Vegas, Nevada

Mr. Clayton Farnsworth has been a teacher and administrator in southern Nevada schools since 1950. He assumed his present position in March, 1965, and since that time has been actively involved in both the actual operation of the Voc-Tech Center and the planning for the planned expansion of it.

In addition to his regular duties related to the Center, Mr. Farnsworth has served as consultant to the Clinton (Iowa) Job Corps, the Florida State Department of Education, and the Stanford Facility Conference.

William E. Blurock
Consulting Architect
1550 Bayside Drive
Corona Del Mar, California

Mr. Blurock is at the present time Principal Architectural Consultant for the firm of William Blurock and Associates, which has completed hundreds of projects in the educational and institutional fields.

Mr. Blurock served as consultant to the Educational Facilities Laboratory, the Stanford University School Planning Laboratory, the Community College Planning Center, and has actively participated in the School Construction Systems Development Project. He has been a member, for the past six years, of the California Council, American Institute of Architects Committee on Schools and Colleges.

Norman L. Rutgers
Assistant to the President
Director of Environmental Systems
Lennox Industries, Inc.
Marshalltown, Iowa

Mr. Rutgers is, and has been, actively involved in the development of environmental systems for many different types of facilities, including vocational-technical facilities. He is a member of the American Society of Heating, Refrigeration and Air Conditioning Engineers, a member of the School Facilities Council, and for two years has been a guest lecturer at the Harvard Graduate School of Design.

Kenny C. Guinn
Managing Associate, Davis-MacConnell-Ralston
230 East 17th Street
Costa Mesa, California

Mr. Guinn's professional experience in the area of school plant planning and construction is a unique one. He has served as School Planning Coordinator for the Clark County School District, Las Vegas, Nevada -- one of the fastest growing districts in the United States. His primary responsibility was for the educational planning and coordination of various projects. Mr. Guinn was directly involved in the opening of twenty-four different facilities to house students; more specifically, seventeen elementary schools, four junior high schools, two high schools, one vocational-technical high school, one administrative complex, and one warehousing and maintenance complex in the short period of two years.

Mr. Guinn has experience as a teacher and administrator on various levels in the field of education.

Harris P. Sharp
Zick and Sharp, Architecture-Engineering Office
Las Vegas, Nevada

Mr. Sharp has been actively engaged in the field of architecture in Nevada since 1947. Prior to that time he practiced architecture in New Mexico, where he was instrumental in the planning and designing of the Los Alamos Atomic Community.

At the present time Mr. Sharp is Chairman, Nevada State Board of Architectural Examiners; Member, Western Conference of Architectural Registration Boards; President A.I.A., Las

Vegas Chapter; and his firm is on the select list of architects for the Clark County School District.

Stanley O. Bokelman
Acting Director
Department of School Facilities
Clark County School District

Mr. Bokelman has occupied many positions in the general area of facility construction, including those of director of school construction, estimator, construction supervisor, architectural draftsman, and production manager.

In his present capacity, Mr. Bokelman works closely with all of the facility construction in the Clark County School District, where some 32 million dollars in construction has been completed to date.

Dr. Thomas T. Tucker
Chairman, Department of School Administration
University of Nevada
Reno, Nevada

In addition to his regular duties at the University of Nevada, Dr. Tucker has conducted many comprehensive school surveys of Nevada educational systems. The surveys conducted have related to: General Control and Administration; Instructional Personnel; Educational Program of the School; School Enrollment Data; Planning for School Facilities; Fiscal Capabilities; and Essential Services.

Dr. Tucker has also served as consultant to the Governor's Council on Education, the County Superintendent's Association, and as Executive Secretary to the Nevada School Trustee's Association.

Dr. James D. MacConnell
Director, School Planning Laboratory
Stanford University

As a result of his work with the School Planning Laboratory, and because of the work of Odell-MacConnell Associates, Dr. MacConnell has gained a wide reputation in the field of both school planning and school construction. He is widely known for his efforts aimed at integrating modern concepts of school construction with principles of child development, curriculum, and methods of instruction.

Dr. MacConnell has contributed articles on both school administration and architecture to many professional journals, and has written or edited several publications of the School Planning Laboratory. He is the author of PLANNING FOR SCHOOL BUILDINGS (Prentice-Hall, 1957). Additionally, Dr. MacConnell has served as an educational consultant to many of the major school systems of the United States, and in a similar capacity has worked with the educational systems of several foreign nations.

Dr. Robert McQueen
Professor, Department of Psychology
University of Nevada

Dr. McQueen has been with the University of Nevada since 1955, and during that time has acted either in an advisory or consultative capacity for many state agencies and local school districts, including the State Department of Education, the Nevada State Hospital, and the Ormsby County School District. He has written many articles pertaining to his major field, and has worked closely with the Research Coordinating Unit for the State of Nevada.

Dr. McQueen holds membership in the American Psychological Association, Nevada Psychologial Association, Phi Delta Kappa, Society of Sigma XI, and Phi Kappa Phi. He is Director of the Honors Program at the University of Nevada, Chairman of the Scholarships and Prizes Board, and a member of the Governor's Committee of the Fulbright Selection Program.

Willard J. Beitz
Principal, Ed. W. Clark High School
Clark County School District
Las Vegas, Nevada

Mr. Beitz was appointed to his present position while he was Principal of Western High School in Las Vegas, and while Clark High School was, in reality, still on the drawing boards. As a result, Mr. Beitz was very actively involved in the total planning ---- construction, facilities, and program ---- for the Ed. W. Clark High School.

While at both Western and Clark High Schools, Mr. Beitz has been instrumental in the development of research programs relating to innovative practices. He has reported on both the practices and the research to numerous national conferences, including those of the American Association of School Administrators and the National Association of Secondary-School Principals.

David L. Jesser
Director, WSSSP for Nevada
State Department of Education
Carson City, Nevada

Mr. Jesser has been associated with the Western States Small Schools Project for Nevada since its inception in 1962. Prior to that time he was a teacher and an administrator in the public schools of Nebraska, Colorado and Guam. His work with the WSSSP has involved Mr. Jesser in the planning of both programs and facilities for the smaller schools of the state and the region.

Mr. Jesser is a member of the Executive Council of the Department of Rural Education, and has served as an educational consultant for schools in Oregon, Idaho, and the schools in the five-state region served by the WSSSP. He has authored many articles and pamphlets having to do with small school improvement, and has presented papers to national conferences such as the Department of Rural Education and the National Education Association.

APPENDIX B

PERSONS ATTENDING AND PARTICIPATING IN THE VOCATIONAL-TECHNICAL FACILITY PLANNING CONFERENCE HELD IN LAS VEGAS, NEVADA MAY 3-5, 1967

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